JAN 1 1932

Volume 18 January, 1932 *Number 1*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Coal Mining Machinery
Lubrication Requirements

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICATION RECOMMENDATIONS

for COAL MINING MACHINERY

BELOW GROUND

DRILLS, HAMMERS, STOPPERS, PUNCHERS AND PICKING MACHINES

Rotating and Reciprocating Elements	TEXACO ALCAID C, ALGOL C, OR TEXACO URSA OIL C
(*Under Water Conditions*)	TEXACO STAR LUBRICANT B OR C, OR TEXACO DRACO CYLINDER OIL
Chuck Fittings and Reduction Gears	TEXACO STAR GREASE 00, NO. 1, OR TEXACO CUP GREASE NO. 1

MINE COMPRESSORS

Cylinders and Adjacent Mechanisms	TEXACO CETUS OR ALCAID OIL

CUTTING MACHINERY

Bearings (*Oil Lubricated*)	TEXACO NABOB, ALEPH, OR ALTAIR OIL
(*Grease Lubricated—Waste Packed*)	TEXACO STAR LUBRICANT B,
(*Other Types*)	TEXACO CUP GREASES TEXACO WOOL YARN GREASE
Gearings and Driving Chains	TEXACO THUBAN COMPOUNDS
Cutter Chains	TEXACO BLACK OIL
Wheel Bearings	(SEE MINE CARS)

COAL LOADERS

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MINE LOCOMOTIVES

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Gears	
(*Exposed*)	TEXACO CRATER COMPOUNDS
(*Enclosed—Bath Lubricated*)	TEXACO THUBAN COMPOUNDS

(*Continued on Inside Back Cover*)

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Published by

The Texas Company, 135 East 42nd Street, New York City

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Vol. XVIII January, 1932 No. 1

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Coal Mining Machinery Lubrication Requirements

SELECTION of lubricants for use on coal mining machinery requires consideration of a number of salient factors. In the order of their importance, these will involve:

1. Machinery maintenance.
2. Power consumption.
3. Conservation of lubricants.

Maintenance is of the utmost importance in the attainment of continued production. It can be realized that any shut-down due to impaired lubrication might very easily disrupt a production schedule, especially if it should involve essential equipment above ground, or if there is no substitute or standby installation.

Continued production is not all, however. It must be carried on at a minimum cost per ton of coal being handled. As a result, power consumption must be reduced wherever possible, for the cost of power consumed will react directly upon the ultimate production costs. Power consumption may be very easily affected by the manner in which lubrication is carried out or the types of lubricants which are used. An oil or grease, for example, which may be too heavy to function effectively in any lubricating system may easily result in an increase in frictional resistance due in part to drag on gear teeth, or solid friction which may be occurring between certain bearings. Ultimately, this will result in an increase in wear, which may directly affect the cost of maintenance.

Conservation of lubricants is in turn of decided importance. In view of the fact that the cost of lubrication must be taken into account in the compilation of production costs, it can be appreciated that if lubricants are stored or handled in a careless manner, there will be a possibility of entry of abrasive foreign matter or other substance which may reduce the lubricating value. The result of this will be the necessity for more frequent application of oils or greases to protect the wearing elements. The means by which lubricants are supplied will also be a factor in this item of conservation. If hand application is practiced, more lubricant will frequently be used than where some type of automatic oiling system or grease lubricator is employed. Furthermore, automatic lubrication, of course, is an insurance against undue contamination.

As a result, with this point in mind, the following discussion of machinery operations, as related to present methods of lubrication, and suggested recommendations for the choice and application of lubricants in the coal mining industry is presented.

The Machinery of Mining

The machinery involved in mining, handling and preparing coal for the market, will depend upon the type of coal and the nature of the mine. In the anthracite fields for example, drilling prior to blasting will be practiced, whereas bituminous coal is customarily broken

out from the seam by cutting machines. Breaker and tipple design with the accessory washing and sizing machinery, will also vary, sizing being more generally confined to anthracite coals.

Courtesy of The Jeffrey Manufacturing Company

Fig. 1—Showing a Jeffrey A-6 post drill. Lubrication is effected by means of a spring oiler. Oil flows automatically along the driving quill to the roller bearing. The same oil lubricates the driving pinions and other gears and bearings, by means of splash from the gear box. The commutator end bearing is grease lubricated.

DRILLING—ROTARY AND PERCUSSION DEVICES

Development of mechanical coal drilling machinery has led to general adoption of the rotary or percussion (impact) type of drill.

The rotary drill will, in general, be of either the motor driven auger type, with suitable reduction gearing, or it will comprise a number of air cylinders with their respective pistons. In drills of the latter type, there will be the crankshaft and connection for transformation of reciprocating motion into rotary motion; a train of gears for bringing about speed changes, and the requisite gear and crankcase.

The principle of the percussion drill involves air pressure acting on the tool mechanism in much the same manner as steam acts on the pistons of a steam engine. In other words, the tool mechanism comprises one or more cylinders with suitable companion pistons, and either an arrangement of valves for the admission of air at the proper time, according to the number of strokes per minute, or percussive frequency required; or, in the valveless type, a piston which acts as its own valve.

Just as in the reciprocating steam or internal combustion engine, where valves are required, there will usually be two sets involved; i.e., (a) those which, by virtue of their timing, control the frequency with which the air pressure is allowed to react on the piston; and (b) the throttle valve whereby the operator is able to control the amount of air admitted to the tool operating mechanism.

Conditions of Operation

More or less the same conditions of wear will therefore prevail as in the reciprocating engine. In the matter of lubrication, however, and the reduction of potential metallic wear between cylinder walls and pistons, etc., an opposite consideration is involved. Instead of relatively high temperatures as in a heat engine, we will have low temperatures with which to deal. Steam gives off heat; petroleum fuels in their combustion develop heat; air, however, in its expansion and passage through pneumatic drills, unless preheated, absorbs heat from its surroundings.

As a result, unless atmospheric temperatures are relatively high, this expansion temperature may run quite low. So pneumatic tool lubricants must be able to withstand low temperatures as a general rule.

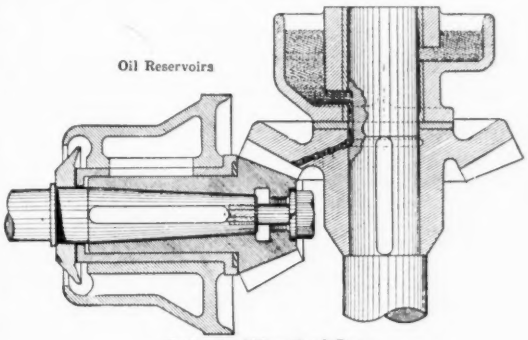
PICKING MACHINES

In the mining of certain grades of coal, picking or punching will be more effective than drilling. The machines used are much similar to large sized drills. They are advantageous for usage where coal seams run horizontally or at an angle not exceeding 15 degrees. The average punching machine is driven either by electricity or compressed air, according to availability of such power. The air machine is frequently termed a snubber. It has been proved a very practical substitute for the handpick and a marked adjunct to production and labor saving. It is also useful for trimming and scraping purposes where roof or floor conditions are bad.

In general appearance and ability both types are much alike. The extensive use of electric power in many mines is, of course, an influencing factor in furthering the usage of the electrically operated machine. The average punching machine is used for undercutting work. It is advantageous in that it is cheap in first cost, easily moved by hand, relatively simple in construction and capable of cutting in such a manner as to result in production of a high percentage of lump coal without excessive explosives. The snubber type can be effectually used in narrow seam cutting where a larger machine would be impractical.

CUTTING MACHINERY

In the mining of certain grades of coal, cutting machines are used for continuous cutting of the seams preparatory to breaking up and removing the coal. Dependent upon such factors as the hardness of the product, the character of impurities, the condition of top and bottom walls, the pitch of the seam, the width and thickness of this latter, etc., such machinery will be variously known as the Breast, Shortwall, Overcutter, Longwall, or Arcwall, according to the specific features in design to meet conditions.



Device for Oiling Bevel Gears

Courtesy of Sullivan Machinery Company

Fig. 2—Oiling plan for the bevel gears on a continuous coal cutting machine. Note oil reservoirs in top bearing of intermediate shaft, which serve both the shaft bearing and gears, via suitable oil passageways as indicated.

The Breast and Shortwall, or continuous cutter, are undercutting devices. The latter is advantageous in that it maintains a high cutting speed, involves comparatively no hazards, and gives a clean, uniform cut with no ribs to interfere with subsequent blasting or shooting. It is ruggedly built, and hence adaptable for service in the hard coal fields.

The former operates on the principle of driving a chain, containing a number of barbs or picks, into the underside of a vein. In the breast machine this chain operates around the periphery of a triangle, the base being forced into the coal while the apex remains at the machine. This cuts a kerf several inches thick on the underside of the seam, the width of the triangle base, and 6 to 8 feet deep. After the triangle has reached the depth desired it is withdrawn, the machine moved to one side and another cut made. This is repeated across the face.

In the Shortwall or continuous machine a long and narrow cutter is used, instead of a triangular one, which is capable of cutting sidewise as well as on the end. With this machine a cut can be run across the face of the seam continuously, to effect a considerable saving of time and labor.

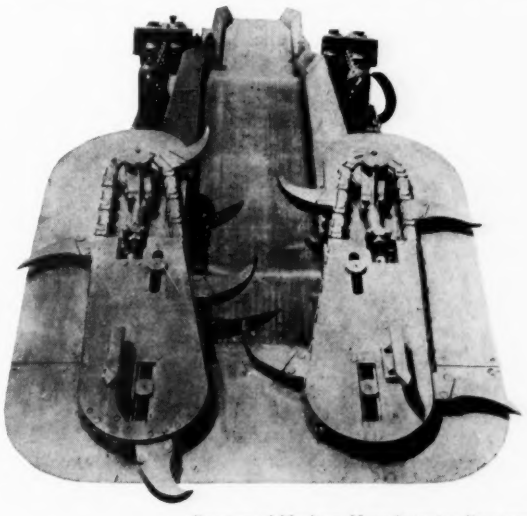
Where the roof is tender the Longwall machine is used to advantage. It is a type of continuous undercutter, normally occupying not more than three feet between the prop line and the coal face.

MECHANICAL LOADERS

Following the drilling, blasting or cutting processes, whereby the coal is loosened and partly broken up, loading into cars is essential. Power mining and the necessity for increased production has brought the mechanical loading machine to the fore as a decidedly advantageous piece of equipment. Essentially its purpose is to transfer coal from the working face to the carrier or mine car, which in turn carries it to the tipple or breaker, where washing and sorting may be carried out. The most common type of coal loader in usage today involves the principles of the conveyor, the scraper or scoop, or the shovel or gathering machine.

In construction three distinct units are involved: (1) The chassis or tractive element which enables movement over the mine floor. (2) The gathering device, shovel, or as it is sometimes termed, the front conveyor, which gathers or accumulates the coal after the latter has been "shot" or broken away from the seam by blasting; and (3) the rear conveyor, which receives the coal from the front conveyor, to deliver it to the mine car.

The scraper or conveyor unit, which serves to carry the coal as it is scooped or otherwise accumulated by the front section, shovel or gathering device, is in principle much the same on practically any type of loader. The tractive elements are likewise similar.



Courtesy of Clarkson Manufacturing Company

Fig. 3—Showing the gathering and digging head in the front of a Clarkson loader. Note chain construction, and the proximity of the lubricated mechanisms to the coal.

In the case of the gathering mechanism, however, the design is quite distinctive, according to the type of loader. In digging type machines it involves a shovel or ram which can be forced under or into the loosened coal, either by driving the tractive elements ahead, or by means of a suitable arrangement of cables, chains and levers.

Other types, in turn, make use of revolving or reciprocating arms which continuously dig into the loosened coal to drag it onto the conveyors for subsequent delivery to the mine cars. With machines of the strictly conveyor types, coal may be loaded by hand or some such device as mentioned above may be incorporated into the design.

MINE CAR SERVICE

The mine car is a practical necessity in virtually every phase of coal mining. From a constructional viewpoint, the wheel bearings are of chief importance in any discussion pertinent to lubrication. Upon their operation will depend the efficiency of the car, and the rate of output, just as is true with many other types of materials handling equipment. They may be of the plain bearing type, or they may embody some form of roller bearing. Use of the latter has been extensive in the modernization of many coal mines, for they afford decidedly positive lubrication, with comparatively little possibility of abnormal power consumption. The labor of lubrication is also considerably reduced.

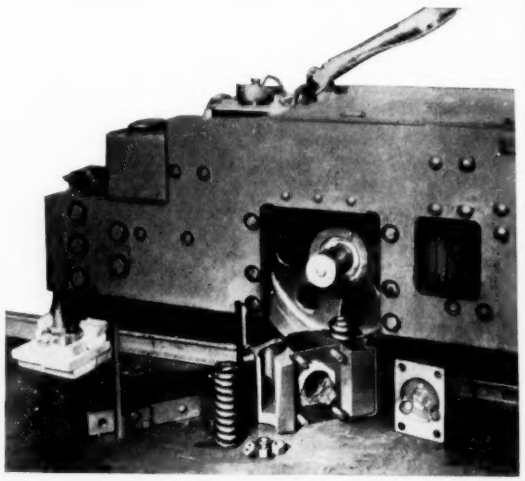
MINE LOCOMOTIVES

There has also been marked progress in the manner of handling mine cars to and from the mines. In the modern coal mine the mule is being largely replaced by electric or air driven locomotives. Electric locomotives are of low, enclosed construction and may be driven by power from a trolley wire or from storage batteries. The trolley system is more apt to be used in main gangways and the battery in shorter leads. Air driven locomotives derive their power from storage tanks, where the air pressure may be as high as 1500 pounds per square inch. These are charged by air compressors at the surface.

VENTILATION—FANS AND BLOWERS

In the soft coal fields, and even in certain anthracite mines, one of the most important factors in mining is the ventilating system. There are frequently deadly as well as inflammable gases concealed in the various coal pockets, and even the coal dust itself may be as explosive as the gases if it comes in contact with a spark or flame. These gases must, therefore, be continually removed in order to make a mine safe and workable. This is accomplished by a carefully planned ventilating system.

Actual circulation of air is accomplished by means of large fans, sometimes ten to twenty feet in diameter, which remove the foul air, and often-times blow in fresh air simultaneously, via suitable shafts and ducts.



Courtesy of The Jeffrey Manufacturing Company

Fig. 4—Illustrating journal box details and the method of removing the box from the axle of a Jeffrey electric mine locomotive. Attention is called to the renewable steel strips on all wearing surfaces and the renewable journal box guides, which take the wear off the locomotive frame.

In many ventilating systems the fresh air enters through the working or hoisting shafts. Regardless of the manner of ventilation, however, the various gangways, headers, galleries, etc., in any gas mine must be so arranged that there is a current of air in them always. As soon as the coal is exhausted from a header, the latter is closed up by "brattice work" so that the air is continually being forced through only those headers which are being worked and which must be kept safe.

BREAKING, SORTING AND CLEANING

The nature of the coal being mined and the location of the fields will determine the extent to which breaking, cleaning and sorting will be necessary as coal is brought from the mine. Normally, as the cars full of coal are brought to the surface they are drawn to the breaker or tipple, where they are dumped or turned over bodily, their contents dropping to a conveyor. Where large lumps are involved, crushing may be necessary prior to sorting and cleaning.

Sorting is a process of screening, being accomplished by passing the coal through screens which are now usually of the shaking and vibrating types. Cleaning can be accomplished by one of three methods, the method that should be selected depending upon the nature

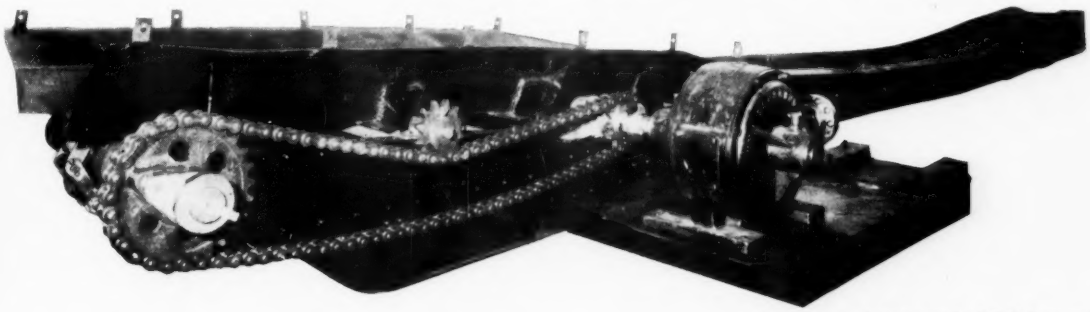
of the coal and its impurities. The three methods are:

(1) Manual inspection and picking.
(2) Separation of free impurities by dry-cleaning mechanical means.
(3) Wet-cleaning, or "the washery process."

Coal with large lumps, about 4 ins. and larger, is usually dry-cleaned by hand picking as the material passes over horizontal shaking screens, or as it is carried along slowly on a wide picking-table conveyor, alongside which men are stationed to remove the bone, slate or refuse.

Screen Design

Screen design in the coal industry involves either rotary or shaking mechanisms. Rotary screens are usually carried on two points of support, one at each end. The mechanism at the driving end, of course, involves the most difficulty from a lubricating point of view, especially in regard to the gears. While these latter will frequently operate exposed, with their lubricants subjected to contamination by dust, dirt and probably moisture, there is a tendency toward the use of guards, in the interest of both safety and more effective lubrication.



Courtesy of Link-Belt Company

Fig. 5—Head section of an under-ground coal conveyor, showing driving chain mechanisms and provisions for lubrication of the motor.

Coal smaller than 4 ins. may be cleaned either wet or dry. The dry-cleaning may consist of running the coal down a spiral chute from which rock or slate, due to its greater density, will be thrown by centrifugal force and thus separated effectively from the coal.

The wet-cleaning process will employ jigs, or wash boxes. The difference in specific gravity of coal and refuse is utilized to effect a separation in the water, by means of pulsations which lift the coal into the upper current, while the refuse, being heavier, settles and is drawn off from the bottom of the system. Whether the coal is sorted or washed first, depends upon the washing system employed.

When coal of ¾ in. size and smaller is to be dry-cleaned it may also be done on air tables, gravity again serving to separate the impurities from the good coal.

Conditions as mentioned above would also affect the bearings to a certain extent, although the housings, if properly designed and installed, would prevent at least the entry of an excessive amount of dust and dirt. In general, plain babbitted bearings are employed, with provisions for grease lubrication by means of compression cups or pressure fittings.

The vibrating mechanism of a shaking screen is of more intricate construction than the driving gears and bearings of a rotary screen. It may develop more potential difficulties in regard to lubrication. This has been fully realized by the manufacturers and adequate provision is usually made for proper application of lubricants to cam surfaces, roller bearings and other elements subject to wear.

Lubrication Practice

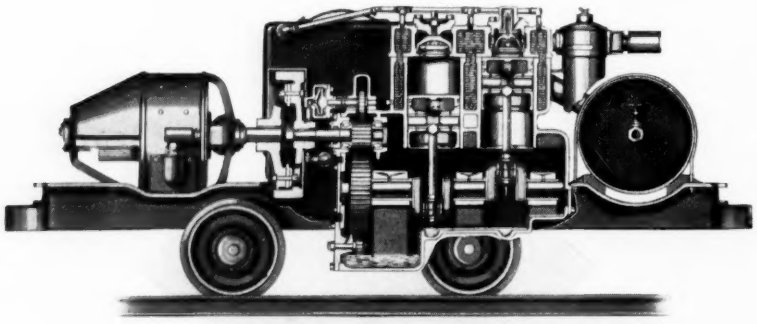
MINE DRILLS

In mine drill operation there will be possibility of comparatively low temperatures, due not only to the moisture, which is usually in the air, but also the fact that narrow, tortuous air passages must generally be traversed in the course of expansion. In air drills it is frequently customary to "lubricate the air," prior to its delivery to the tool, a suitable lubricating device being installed in the air line a short distance back from the throttle valve.

Where drill construction involves gearing, the matter of lubrication requires that gears, crankshaft bearings and cylinders must be served. As a rule this can be adequately taken care of by means of two lubricants; one, of the nature of a liquid grease or petrolatum to serve the gears and crankcase bearings, etc., the other, an oil to serve the cylinders.

There is an increasing tendency to equip the crankshaft of the more modern type of drill with ball bearings, the connecting rod being

furnished either with plain or roller bearings. In view of this, the crankcase lubricant must be such as to lubricate these varied bearings adequately, with the least amount of internal friction and no tendency to separate. In consequence, grease for this purpose should be selected with the utmost thought as to its stability.



Courtesy of Ingersoll-Rand Company

Fig. 6—Section through an Ingersoll-Rand low head mine car compressor, showing gear, bearing and cylinder construction, and means whereby complete lubrication is accomplished. Oil is lifted from the well by means of an open gear, passing to the constant level pans, located under the connecting rods. From there it is splashed to all internal moving parts by the oil dipper on the ends of the connecting rods.

In both crank and gear cases, by virtue of their dust proof construction, there is but little possibility of dirt or dust entering to contaminate the lubricants. They should, therefore, function effectively for indefinite periods, with but little renewal. In operation the heaviest duty is imposed by reason of the churning action, to which such lubricants will be subjected.

The Effect of Water

The combined effects of water and dirt will impose severe duty on any lubricant, however suited it may be to the actual operating requirements. Water, for example, will tend to wash off the lubricating film from wearing surfaces. Dirt will be abrasive. It is for this reason that compounded lubricants, i.e., mineral oils containing more or less animal oil or soap in compound are recommended for the lubrication of such equipment as hammer drills, where operating with water. Such lubricants function on the same principle as do steam cylinder oils. In other words, they emulsify with water, by virtue of their fatty content, creating an adhesive emulsion which sticks tenaciously to all wearing elements, and resists the washing effects of water.

Compounded lubricants are often recommended for air drills wherein water is intentionally mixed with the air to serve the purpose of washing cuttings from the hole, in much the same manner as a soluble oil solution washes metal cuttings away from the tool in the machine shop drill, etc. Where pneumatic tools are designed to function dry, they should be absolutely dry, that is, free from moisture as far as possible. On such equipment straight mineral lubricants are generally regarded as most satisfactory.

Dust and Dirt

Foreign matter, such as coal or rock dust, may gain entry through careless handling of the drill. Some dirt may also be carried through the drill by the air itself. Any such foreign matter will be detrimental and cause abnormal wear.

Clean, pure air is not always available; it will all depend upon the location of the compressor, the air intakes. whether or not air filters are installed, and the cleanliness of the air coolers and air lines. The use of the portable mine compressor has proven advantageous in eliminating air line troubles.

Regardless of the system of compression, however, there will also be the possibility of particles of rust being carried along by the air, especially where lubrication has not been adequate in the protection of those parts of the system exposed to moisture. Then, too, particles of rubber from the air hose and gaskets may find their way into the air passages and cylinders, along with other foreign matter, to interfere materially with the free operation of the drill mechanism. To eliminate such troubles a wire strainer of suitable fineness located in the inlet pipe has been found advantageous in removing much of the above mentioned foreign matter from the air prior to usage.

Applying Lubricants

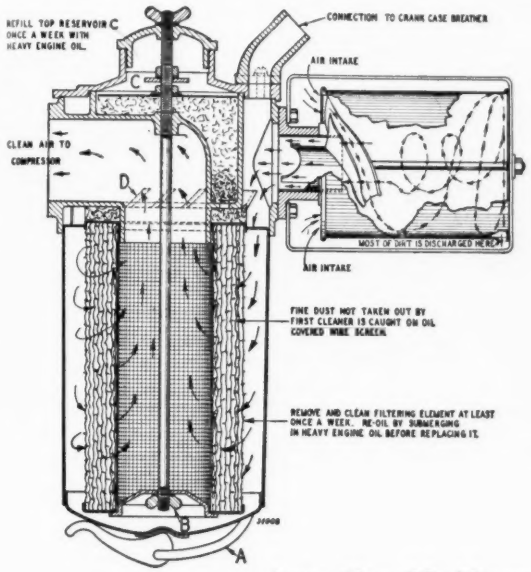
To protect mine drills further against the abrasive or corrosive effects of foreign matter, care must be exercised in regard to the feeding of lubricants. Where automatic lubrication is provided by means of pipe line lubricators or atomizers which mechanically deliver the requisite amount of oil to the air lines, there will be the least possible chance of dust or dirt being carried in, provided that the oil is properly stored and handled prior to application.

Where drills must be periodically oiled by hand, however, in the absence of automatic means of lubrication, there may be more possibility of accidental entry of dust or dirt. At best, operator's hands will be dirty, and in mines the atmosphere will often be laden with

dust. Of course, under such conditions, the lubricants for current usage should be stored and handled with the utmost care.

PICKING AND PUNCHING MACHINES

In view of the fact that the lubricating problems of compressed air and electric driven


REFILL TOP RESERVOIR C ONCE A WEEK WITH HEAVY ENGINE OIL.
CONNECTION TO CRANK CASE BREATHER
AIR INTAKE
CLEAN AIR TO COMPRESSOR
MOST OF DIRT IS DISCHARGED HERE
AIR INTAKE
FINE DUST NOT TAKEN OUT BY FIRST CLEANER IS CAUGHT ON OIL COVERED WIRE SCREEN
REMOVE AND CLEAN FILTERING ELEMENT AT LEAST ONCE A WEEK. RE-OIL BY SUBMERGING IN HEAVY ENGINE OIL BEFORE REPLACING IT.
C
D
B
A

Courtesy of Ingersoll-Rand Company

Fig. 7—Section through a portable mine car compressor air filter showing how intake oil is cleaned before going to the cylinders.

punching machines are so akin to those problems involved in the operation of percussion type drills, reference is made to the discussion pertaining to such equipment. Essentially, a low pour test, medium viscosity oil will serve for normal conditions of air cylinder lubrication. For other parts of the compressed air driven puncher or snubber, as well as the electric machine, including the reduction gears, motor bearings, etc., a medium bodied grease compounded with a highly refined, low pour test straight mineral oil, will meet normal operating requirements.

PORTABLE MINE COMPRESSORS

The extent to which the use of compressed air has been adopted for operation of coal mining machinery has led to the development of a type of mine compressor which is particularly unique from the viewpoint of the attention which has been given to mobility and dust proof construction. Protection of air tool lubrication can be improved by locating the source of air supply as close to the tools as possible. To render this complete, however, the compressor itself must be properly lubricated.

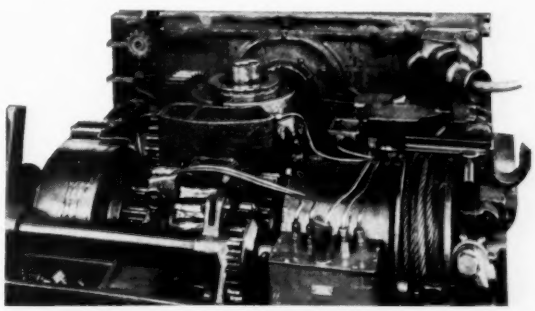
Portable mine compressors are designed to exclude dust as far as practicable, sheet metal covers being used to protect the working parts, wherever exposed, and suitable air filters to purify the intake air. Splash lubrication is provided for as the simplest method of insuring positive distribution of oil, commensurate with the design, the parts involved and the working conditions.

CUTTING MACHINERY

Machine design must be thoroughly understood in studying the lubrication requirements of coal cutters. Such machines have proved their value as production elements, but they must be effectively lubricated to enable their working elements to stand the severe duty to which they are subjected. Dependent upon their design either grease or oil must be used. Some machines can be lubricated by a soft grease or an oil of from 300 to 500 seconds Saybolt viscosity at 100 degrees Fahr. In other cases where gears and bearings of these machines are oiled through the same channel this is best accomplished with a heavier oil applied immediately after cutting, while the parts are at operating temperatures.

With regard to the respective elements, the armature ball bearings on many machines must be oil lubricated using a high grade mineral oil of the above mentioned viscosity, for in order to keep coal and grit out, the oil holes are made so small that only a light oil will reach the bearings. Where a dust tight cap and large oil holes are provided, however, a light grease is frequently preferable.

Cutter chains in turn can generally be lubricated with waste machine oil or black oil. Care should be taken to clean both the chains and machines quite often. They become dirty very quickly and their life will be greatly prolonged



Courtesy of The Jeffrey Manufacturing Company

Fig. 8—Operating mechanism of a Jeffrey short-wall coal cutter. Note the Manzel force-feed lubricator and oil distributing pipes.

and their efficiency increased by close attention. Some operators soak the chains in oil after cutting each room.

When cutting machines are travelling, the trucks are driven through a worm and gear, which in turn drives the wheels by means of

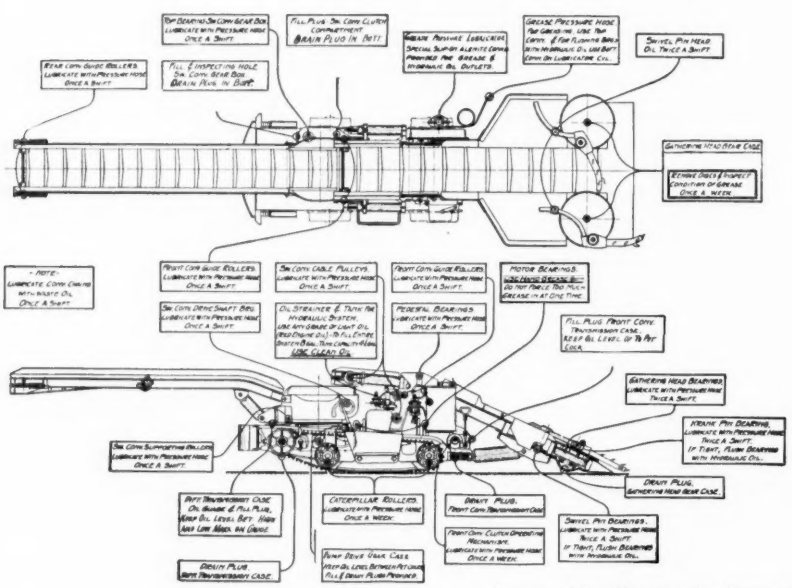
chains. All such parts with the exception of wheel bearings are best lubricated with a medium bodied gear lubricant of highly penetrative and adhesive characteristics. Wheel bearings should be studied with respect to construction, as discussed under mine cars.

Parts Replacement

In addition to enabling proper operation with a minimum of power consumption, lubrication should also be considered with respect to its ability to counteract the effects of wear. This latter will often be extensive on the wearing elements of any coal mining machine, regardless of the attention given to lubrication. The presence of excessive amounts of coal dust and other abrasive matter, and the possibility of dampness all render the attainment of effective lubrication quite a problem. Cost of upkeep and repair will therefore be comparatively high in many mines.

Certain gears and bearings will wear more than others, regardless of lubrication. In such cases the best to be expected from this latter is that it will reduce the rate at which such wear takes place, enabling gears to run in proper mesh as long as possible, and increase the life of bearings. Improper meshing of gear teeth, or bearings wherein abnormal clearances prevail, will foster such difficulties as increased wear, noise, loss of power and the possibility of breakdown.

With this thought in mind, whenever it is necessary to renew gears or bearings, it will be advisable to investigate whether or not the entire train, or all the bearings warrant renewal. Merely to install a new gear, or renew the bearing of a gear shaft, will not insure correct meshing in case the companion gears or bearings are worn to any great extent. In fact, this would only lead to more rapid wear of the new element. The use of heavier grades of gear lubricants might offset high tooth clearances to a certain extent, but the increase in power consumption involved due to possible drag would certainly not render this economical under continued operation.



Courtesy of Joy Manufacturing Company

Fig. 9—Lubrication chart of a mechanical coal loading machine. Note the constructional details and specific instructions for lubrication.

LUBRICATION OF COAL LOADERS

Coal loading machinery is subjected to practically the same conditions of operation as coal cutters, functioning in intimate contact with abrasive materials which are decidedly prone to promote wear. In consequence the matter of lubrication must be given careful consideration, including the protection which proper choice of lubricants will insure.

Gears, chains and bearings will be involved according to the design of the machine. In addition, on certain loaders built for hydraulic operation, oil will be required in the hydraulic system. Such oil also serves to lubricate the interior parts of such a system.

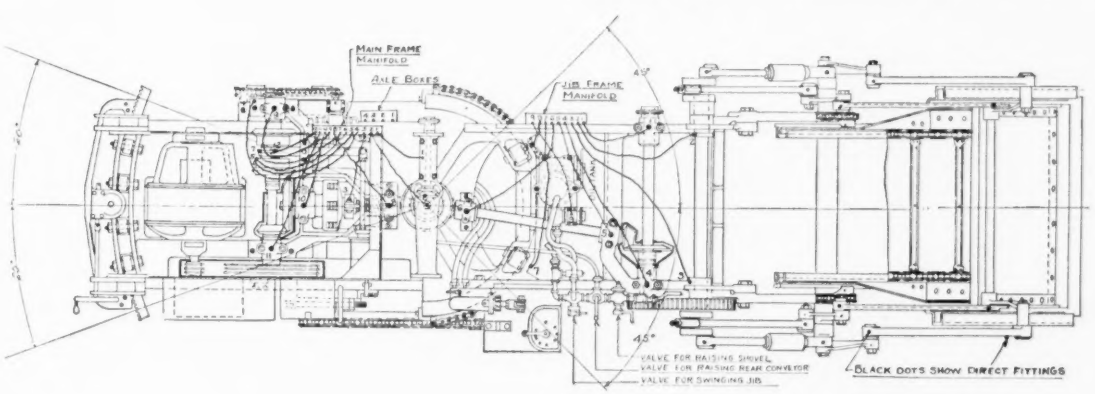
Extensive thought has been given to the development of automatic lubrication in appreciation of the productive importance of the loading machine. Automatic lubrication may involve merely the lubrication of gearing and gear shaft bearings by splash from the oil in a reservoir which is formed by the gear case, or the use of some form of pressure lubrication, handling either grease or oil, according to requirements of the wearing elements and the manner of housing.

Automatic lubrication is advantageous in that it usually enables the lubricant to perform its intended function of reducing metallic friction and wear more effectively. Furthermore, it promotes economy of lubricants, for as a general rule lubricating systems will be of more nearly an oil-tight nature. Such construction has a further advantage in that it more com-

pletely prevents entry of mine waters, coal dust or other abrasive foreign matter.

Where the operating mechanism can be served from a central reservoir, it will usually be advisable to use a relatively heavy bodied, straight mineral oil. Such a product will follow all gear and pinion teeth readily, will penetrate throughout all normal bearing clearance spaces and will insure that chain roller or link mechanisms will receive adequate lubrication.

It is also quite possible to use a grease of fairly low consistency in certain gear cases. In fact, this is the recommendation of some builders. Care should be taken, however, that any grease used is compounded with a high grade of low pour test, mineral oil, otherwise under low temperature conditions there will be possibility of congealment and lack of sufficient lubrication, especially if low bearing clearances prevail.



Courtesy of Myers-Whaley Company, Inc.

Fig. 10—Top view of a Myers-Whaley automatic coal loading machine. This machine is equipped for pressure grease lubrication, with high pressure hose connections direct to each of the bearings, and spring pressure cups on each of the transmission bearings. Lubricant manifolds are located on the side of the machine, with leads from each shown in heavy black.

Where machines for coal loading purposes may involve hydraulic operation for manipulation of the gathering, shoveling or conveying elements, a high grade machine or engine oil of approximately 100 seconds Saybolt viscosity at 100 degrees Fahr. should be used. Such a product, if of sufficiently low pour test, should function effectively and give adequate lubrication to all plunger rods, etc. The necessity for low pour test is to insure against the oil becoming so sluggish at low temperatures as to require excessive power consumption in the operation of the plungers.

For the exposed parts of the average coal loader, such as the chains, tractive elements, bearings, etc., which may require periodic hand lubrication, machine oil of about 200 seconds Saybolt viscosity, or a medium compression cup grease should be used, according to the means provided for application.

Exposed gears require a straight mineral, semi-fluid lubricant of from 1,000 to 2,000 seconds Saybolt viscosity at 210 degrees Fahr. Such a product will insure adequate protection of gear teeth, with minimum loss through dripping or the action of centrifugal force; drag will also not be extreme.

MINE CAR WHEELS

In volume the amount of lubricants required for mine car bearings will frequently exceed that used for any other type of mining machinery. It is interesting to note that as originally designed, mine cars were equipped with plain bearing axles. Lubrication of these latter was, therefore, a matter of daily routine, black oils or cheap greases being applied by hand. Where such bearings are still in use this practice prevails today. Such lubrication, however, is usually independable, the labor cost being abnormally high. Furthermore, there is no assurance of positive lubrication or protection of the bearings against the entry of moisture, coal dust or other material which would score the bearings.

To reduce the ultimate cost of replacement and to bring about labor economies, careful attention has, therefore, been given to improvements in mine car wheel bearing design. Positive and relatively automatic lubrication must be attained if mine cars are to stand up under the higher speeds resulting from the use of the mine locomotive. Reduction in load required to move the cars means the possibility of handling more cars per train. This is decidedly advantageous in the interests of increased production.

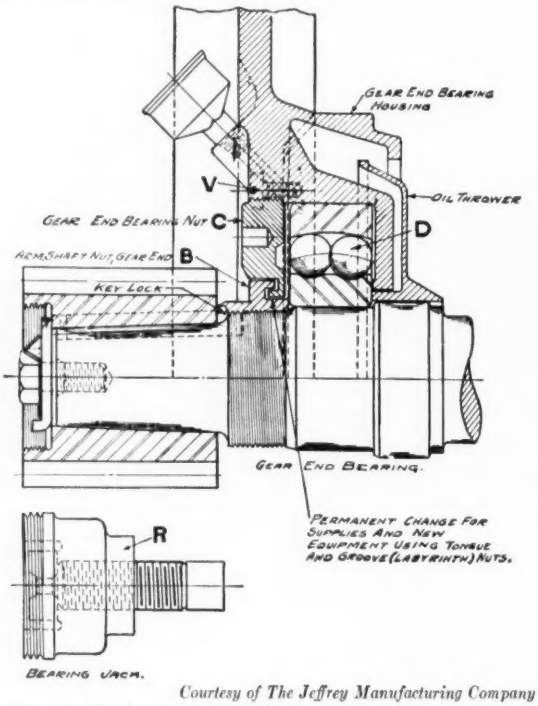
Types of Bearings

To enable more complete understanding of the lubricating requirements, it is fitting to discuss the design of the several types of mine

car wheel bearings in use today. These will include:

1. Plain bearings,
2. Cavity type, self-oiling wheels,
3. Solid roller bearings or
4. Flexible roller bearings.

According to the type of car, these may be installed on fixed or floating axles.



Courtesy of The Jeffrey Manufacturing Company

Fig. 11—Showing gear end ball bearing construction on an electric mine locomotive. Note in particular provisions to prevent leakage of lubricant from the bearing.

Plain Bearings

Where plain bearings are still in service they are in general so constructed as to enable the use of oil-saturated wool yarn or waste packing. In brief, bearing design is much similar to that so extensively used in the railway service. Provided that regular attention is given to loosening and re-saturating of the waste or oil-carrying material with a suitable grade of straight mineral machine or car oil, or a light grade of liquid grease, very effective lubrication should be attained.

Of course, due care must always be observed to prevent matting or glazing of the oil-carrying materials, for this will reduce the capillarity of the packing, preventing the requisite amount of lubricant from being transmitted to the rotating axle surface.

The packing of journal or car wheel bearing boxes is quite an art, as is also the determination of the extent to which proper lubrication is being obtained. In the first place, the waste or wool yarn should be of good quality, long strand material. It should be saturated in accordance with standard railway practice, then drained until the oil content is approximately 2 pints per pound of waste. It should then be packed in a homogeneous mass, not too tightly, and yet in a sufficiently compact manner to insure continued contact with the axle. At periodic intervals it should be loosened to insure that its oil transmitting ability is kept uniform.

Cavity Type Wheels

For lubrication the cavity type of wheel depends upon an oil or grease reservoir around the hub. During rotation the lubricant is fed to the axle or journal through port holes staggered in the hub. Such delivery of lubricant, however, only occurs when the car is idle or running slowly. At higher speeds centrifugal force tends to carry the lubricant to the outer surface of the reservoir. For this reason, due to possibility of leakage, care should be observed in regard to the amount of lubricant used. In general, the lubricant level should be maintained on a line with the lower part of the axle when the car is at rest.

Bearings of this type can be best served by a lubricant of medium heavy body, yet it should have a sufficiently low pour test to insure proper flow through the distributing ports. A highly refined straight mineral engine or car oil of medium to heavy viscosity will in general be best suited to the operating conditions and will insure most complete protection of the bearings.

Where grease is desired or deemed necessary by reason of possible leakage of oil, a semi-fluid product, compounded with low pour test mineral oil, will adequately serve the purpose.

Roller Bearings

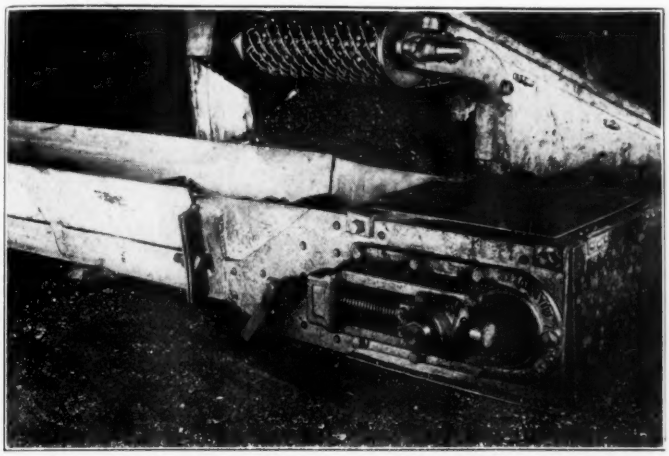
The application of the roller bearing to mine car service has been a decided step forward in the interest of positive lubrication and labor reduction.

Installation of both solid and flexible roller bearings is comparatively simple. Roller bearings, regardless of their type, are decidedly positive, automatic and economical from a lubricating point of view. By reason of their careful construction all lubricants used should be of the highest degree of refinement, and selected with the utmost caution. The function of these latter is dual in that they must not only protect the rolling elements against corrosion, but also lubricate the contact surfaces of these elements.

In mine car service, soft or semi-fluid greases are usually recommended for roller bearings. Where the latter are of solid, cylindrical or tapered construction, a somewhat more inert

grease will be advisable than on hollow flexible bearings. It will be found that such a product will furnish a better cushion between the axle and rollers than a more liquid grease. Furthermore, it will also form a better seal against possible entry of dust or dirt.

For flexible roller bearings, however, the lubricant should be a semi-fluid or so-called liquid grease. The usual construction of such bearings provides for the hollow spaces within the rollers serving as grease reservoirs. In consequence, the lubricant must be sufficiently fluid to pass through and penetrate to all the surfaces of contact. It should never remain inert within the rollers.



Courtesy of Gellatly and Company, Inc

Fig. 12—Showing a Gellatly underground coal conveyor. The main bearings of this machine are equipped for pressure grease lubrication. The speed reducers in the power unit are equipped with anti-friction bearings throughout.

Where roller bearings are constructed of a relatively oil and dust-tight nature they should not require re-lubrication more frequently than once every six months. Wherever possible the lubricant should be applied by a pressure gun of capacity commensurate with the proper amount of lubricant required per bearing. In this way, just the right amount, as recommended by the manufacturers, can be injected, with the least possibility of subsequent leakage or development of abnormal internal friction.

MINE LOCOMOTIVE REQUIREMENTS

Mine locomotives operate under much the same conditions as do mine cars, their lubrication requirements are, therefore, similar to other underground mining machinery. Axle bearings are lubricated according to the type of bearing; the same recommendations apply as for mine cars.

Exposed gears require the use of a straight mineral, residual lubricant of about 1,000 seconds Saybolt viscosity at 210 degrees Fahr. Such a product will adhere tenaciously to the gear teeth and overcome vibration and wear. At the same time it will be sufficiently fluid at low temperatures to follow the teeth without channeling. This same lubricant should also be used on chain drives. On the other hand, where gears and chains are enclosed in oil-tight housings, a somewhat lighter lubricant can be used to advantage, with the possibility of reduction in drag and power consumption.

Where locomotives are driven by compressed air the cylinders should be lubricated by a medium bodied air compressor oil. Low pour test is absolutely essential. These cylinders generally exhibit a heavy frost line, indicating a low temperature from the expansion of the air. Otherwise their requirements are similar to those of the portable mine compressor.

VENTILATING FANS AND BLOWERS

These devices are usually located above ground. They are driven either by small reciprocating steam engines or by electric motors. They are frequently located at a considerable distance from the power plant. As a result, with steam driven units the steam reaches the cylinders in a wet condition, and a compounded oil is necessary. However, the service is usually continuous and the cylinders, therefore, remain warm with but little possibility of cylinder condensation. In consequence, a steam cylinder oil with a moderate amount of compound, i.e., five per cent. to eight per cent., will operate satisfactorily. As these engines are apt to be more or less unattended, their external lubrication is frequently accomplished by grease cups, using a medium grade of grease.

Splash lubrication of certain bearings, where enclosure is possible, is however also very dependable. Under such conditions a medium viscosity engine oil will be satisfactory.

Electric motor bearings, in turn, can be either oil or grease lubricated, according to design, construction, and provision for lubrication.

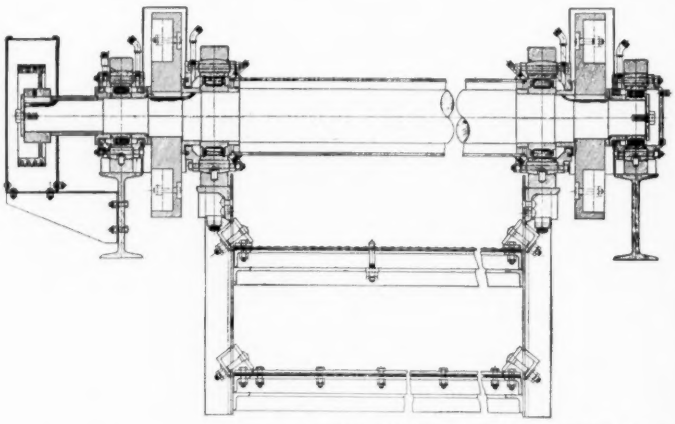
BREAKING AND CLEANING MACHINERY

The conditions to which such machinery is normally subjected have led to more or less general adoption of grease lubricated bearings. Grease lubrication is advantageous inasmuch as grease under sufficient pressure will more effectively protect the bearings against entry of coal or rock dust. As a rule, a medium bodied compression cup grease will adequately serve

the purpose. Where certain bearings are designed for oil lubrication, however, a straight mineral machine oil of approximately 500 seconds Saybolt viscosity at 100 degrees Fahr. will, in general, carry the pressures satisfactorily.

Gear lubrication, in turn, may develop problems whatever the method of sorting or cleaning involved. Many of such gears with the accessory driving chains will operate exposed on certain machines.

Where water is employed, as with the jig or washer, the lubricant must possess certain naturally adhesive characteristics in order that it may resist the washing-off effect of water. A straight mineral lubricant of approximately 1,000 seconds Saybolt viscosity at 210 degrees Fahr., should normally withstand these conditions provided it is properly applied at frequent intervals.



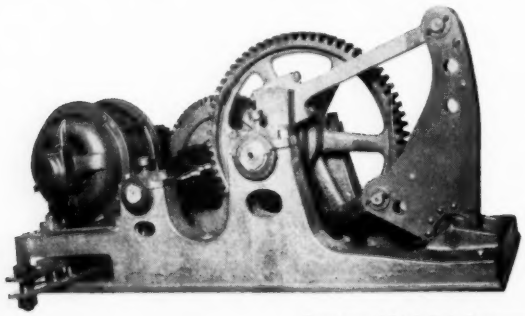
Courtesy of Allis-Chalmers Manufacturing Company

Fig. 13—Section through an Allis-Chalmers double-deck vibrating screen. Note that the vibrating shaft is carried on two over-sized roller bearings, mounted on the supporting frame in self-aligning, dust-proof housings. The vibrating screen body bearings are of similar design. Pressure grease lubrication is provided for as indicated.

Screen Operations

Where rotary screens are involved grease is probably a better lubricant than oil, due to its ability to maintain a more effective seal against entry of abrasive foreign matter under the prevailing operating conditions. It must be a product insoluble in water, however, due to the possibility of its having to withstand the washing action of any water used during screening. As a rule, a grease of medium body or consistency will be best suited to these conditions and capable of ready application by means of some form of compression cup or pressure lubricator.

For the gears, a lubricant must be used which will not only form a protective film to counteract the abrasive effect of dust, dirt, etc., but will function irrespective of temperature, moisture, or weather conditions. This is a broad requirement, one in fact that very few compounded lubricants or greases will meet with any degree of success. Experience has proved that a straight mineral residual product, of fairly inert characteristics, will give the most satisfactory results. Usually a viscosity of approximately 200 seconds Saybolt at 210 degrees Fahr. will adequately serve the purpose. On the other hand, certain conditions might require a higher viscosity of say 450 to 1,000 seconds Saybolt.



Courtesy of Link-Belt Company

Fig. 14—Assembly of a shaker conveyor drive unit. Bearings are provided with means for pressure grease lubrication.

Heavier lubricants are advantageous in that their highly adhesive characteristics enable them to resist the effects of centrifugal force under higher speed conditions, provided they are sparsely applied, yet with sufficient frequency to insure maintenance of a suitable film.

Shaking Screens

Here again grease lubrication has been found to be very satisfactory for bearing service, affording the requisite protection by preventing the entry of dust and dirt. As a rule, some form of compression or pressure grease lubricating device should be used to insure as nearly positive lubrication as possible. In such equipment a medium bodied compression cup grease will be suitable. Where oil is desirable, as on certain types of anti-friction bearings, a medium viscosity straight mineral product will be found suitable.

Cam operations also require consideration. Where cams may tend to run hot, a problem of under-lubrication and abnormal wear of cams and straps may frequently develop. The proper lubricant to counteract such conditions is a high melting point grease of relatively heavy consistency. The lubricating film developed by such a grease is decidedly tenacious and resistant to the thinning-out effects of higher temperatures.

Printed in U. S. A. by
Edgar C. Ruwe Co., Inc.
72 Washington St., N. Y. C.